

ASSEMBLING AND  
USING YOUR

*Heathkit*

Vacuum Tube Voltmeter  
Model V-4A



THE HEATH COMPANY  
BENTON HARBOR, MICH.

PRICE \$1.00

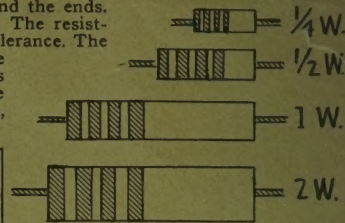


## USEFUL INFORMATION FOR KIT BUILDERS

Resistors are identified by a color code used in several bands around the resistors. There are two general types of resistors. One, the uninsulated type, has the connecting wires bound around the ends. The other, the insulated type, has the wire connected internally and coming out the ends. The resistance code uses three bands or colors, while a fourth, usually silver or gold, indicates the tolerance. The colors are arranged so that the first two indicate the first two figures of the resistance, while the third indicates the number of digits (zeros or multiplier) which follow the first two figures. On uninsulated resistors, the body is the first figure, the end color the second figure, and the dot the number of digits. On insulated resistors, the band nearest the end is the first figure, the next band is the second figure and the third band the number of digits.

**WATTAGE.** Resistors are rated as to wattage (power dissipation) according to size. The chart shows approximate sizes which vary with manufacturers. To determine wattage size necessary multiply current through resistor in amperes by voltage drop across resistors in volts. Example—A plate loading resistor for a tube drawing 10 milliamperes (.01 Amperes) has a voltage on one side of 300 volts and on the other side 200 volts, giving a drop of 100 volts. Therefore  $100 \text{ volts} \times .01 \text{ A.} = 1 \text{ Watt.}$

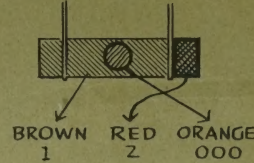
A higher wattage resistor can always be substituted for smaller size.



WATTAGE SIZES

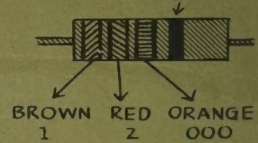
Uninsulated Insulated	Body Color First Ring	End Color Second Ring	Dot Color Third Ring
Color	First Figure	Second Figure	Number of Digits
Black	0	0	None
Brown	1	1	0
Red	2	2	00
Orange	3	3	000
Yellow	4	4	0,000
Green	5	5	00,000
Blue	6	6	000,000
Violet	7	7	0,000,000
Grey	8	8	00,000,000
White	9	9	000,000,000

### UNINSULATED TYPE



### Examples

### INSULATED TYPE Fourth Band For Tolerance



## Some Popular Sizes of Resistors

RESISTANCE IN OHMS	BODY OR FIRST BAND	END OR SECOND BAND	DOT OR THIRD BAND
50	Green	Black	Black
250	Red	Green	Brown
1500	Brown	Green	Red
30,000	Orange	Black	Orange
220,000	Red	Red	Yellow
1 Megohm	Brown	Black	Green

The fourth ring or other end may be silver (10% tolerance) or gold (5% tolerance) or it may be omitted entirely which indicates 20% tolerance.

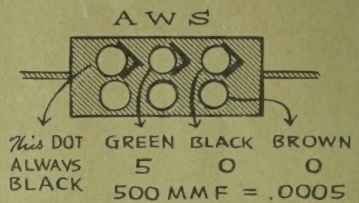
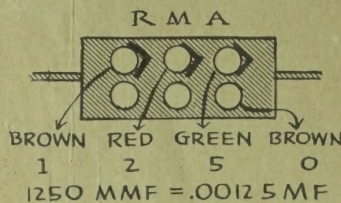
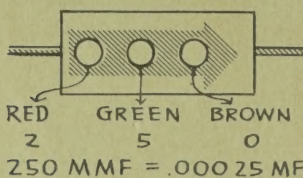
## Condenser Code

Condensers use the same code as resistors and are read in micromicrofarads.

If there is one row of dots, they are read in direction of arrow or if manufacturer's name appears in the same direction as name. If two rows of dots appear, it can either be of two different codes: The RMA or the AWS (American War Standard). In the RMA, the top row of dots are the first three figures (carried to three figures), the bottom row are left to right the voltage rating, tolerance, and decimal multiplier.

In the AWS code, the top row of dots are the first three figures while the bottom row are, left to right, characteristic, tolerance, and decimal multiplier.

### Examples



## Some Commonly Used Sizes of Condensers

MMF.	MF.	FIRST DOT	SECOND DOT	THIRD DOT
10	.00061	Brown	Black	Black
50	.00005	Green	Black	Black
100	.0001	Brown	Black	Brown
250	.00025	Red	Green	Brown
500	.0005	Green	Black	Brown
1000	.001	Brown	Black	Red
3000	.003	Orange	Black	Red
10,000	.01	Brown	Black	Orange

The tolerance rating corresponds to the color code, i.e., red — 2%, green — 5%, etc.

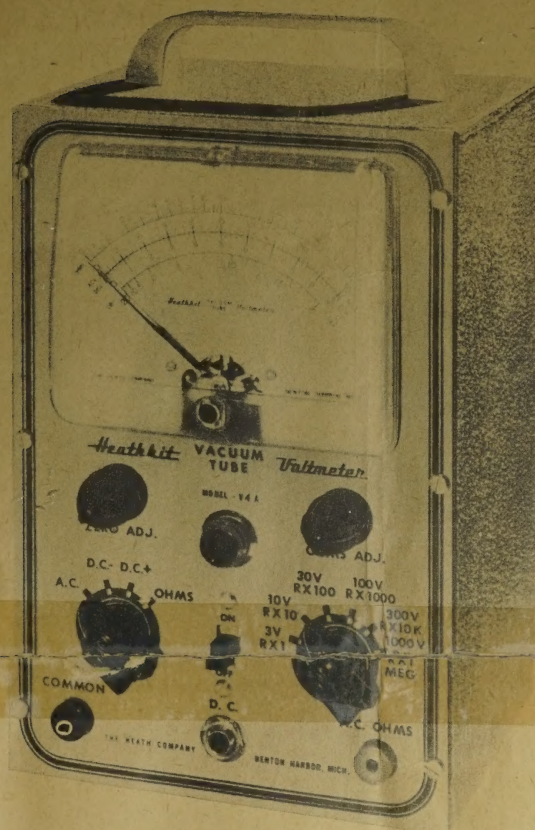
The voltage rating corresponds to the code multiplied by 100. Example: Orange dot — 300 volt rating; Blue — 600 volt rating.



# HEATHKIT

## MODEL V-4A

# VACUUM TUBE VOLTMETER



### SPECIFICATIONS

Power Requirements:	105-125V 50/60 Cycle AC, 10 Watts.
Overall Size:	10" high x 6" wide x 5 $\frac{7}{8}$ " deep.
Kit Shipping Weight:	8 pounds
Meter:	4 $\frac{1}{2}$ " Streamlined case with 200 microampere movement.
Multipliers:	Carbofilm precision type.
Tubes:	1 - 6SN7 Twin triode meter bridge. 1 - 6H6 Twin diode AC rectifier.
Power Supply:	Power transformer and selenium rectifier.
Batteries:	2- 1 $\frac{1}{2}$ Volt standard flashlight cells.
D. C. Voltmeter: 6 Ranges:	0-3, 10, 30, 100, 300, 1,000 volts full scale. With accessory probe to 30,000 Volts
Input Resistance:	11 megohms (1 megohm in probe) on all ranges. 1,100 megohms with accessory probe.
Sensitivity:	3,666,666 ohms per volt on 3 Volt range.
Circuit:	Balanced bridge (push-pull) using twin triode.
Electronic AC Voltmeter: 6 Ranges:	0-3, 10, 30, 100, 300, 1,000 Volts full scale on linear scales reading R. M. S. (.707 of negative peak).
Circuit:	Diode with adjustable compensation.
Electronic Ohmmeter: 6 Ranges:	Scale with 10 ohms center x1, x10, x100, x1,000, x10K, x1 Meg. Measures .1 ohm to 1,000 megohms with internal battery.



# ASSEMBLY OF THE HEATHKIT

## MODEL V-4A

# VACUUM TUBE VOLTMETER

It is not difficult to construct this instrument if the instructions are carefully followed. Do not rush the construction. Take time to do a first class job to insure years of troublefree operation. Hurried work increases the chances of mistakes and subsequent difficulties. THEREFORE READ THIS MANUAL FULLY THROUGH BEFORE STARTING THE ASSEMBLY.

Begin by checking the parts against the parts list. Identify each part, using the charts on the inside of the cover of this manual where necessary. Thus, you will avoid throwing away any small parts with the packing.

Familiarize yourself with the layout by studying the pictorial diagrams and the photo print. Then proceed by following the step-by-step assembly instructions.

Read the note on soldering on the inside of the back cover. Make a good mechanical joint of each connection with clean metal to clean metal. Use only good quality rosin core radio type solder. Pastes or acids are difficult to remove and minute amounts left combine with moisture from the air forming a corrosive product. Weeks or months later corrosion may result in untimely failure. This corrosive product is also a fairly good conductor and may cause short circuits which damage the meter.

**NOTE: ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTES ARE USED.**

Small changes in parts may be made by the Heath Company. All parts supplied will work just as well as the part for which it was substituted. All substitutions will be of equal or better quality than the original, and will be made in order that a minimum delay will occur in filling your order. The precision resistors are marked with K = 1,000 and M = 1,000,000. Thus, a resistor marked 90K = 90,000 ohms and one marked 9.9M = 9,900,000 ohms or 9.9 megohms.

Resistors and controls have a tolerance rating of plus or minus 20% unless otherwise stated. Therefore, a 100K ohms resistor may test between 80K ohms and 120K ohms. Frequently, condensers show an even greater variation such as minus 50% to plus 100%. This Heathkit is designed to accommodate such variation.

The tube socket pins are numbered from 1 to 8 starting at the keyway and reading clockwise when viewed from the bottom.

The chassis and panel are wired separately as far as possible. Then they are fastened together and the wiring is completed.

### STEP BY STEP ASSEMBLY

Use of bare wire where indicated will facilitate wiring, but insulated wire may be used. Use spaghetti (insulated sleeving) over bare wires on condensers or resistors where necessary to prevent the leads from accidentally touching other bare wires or metal parts.

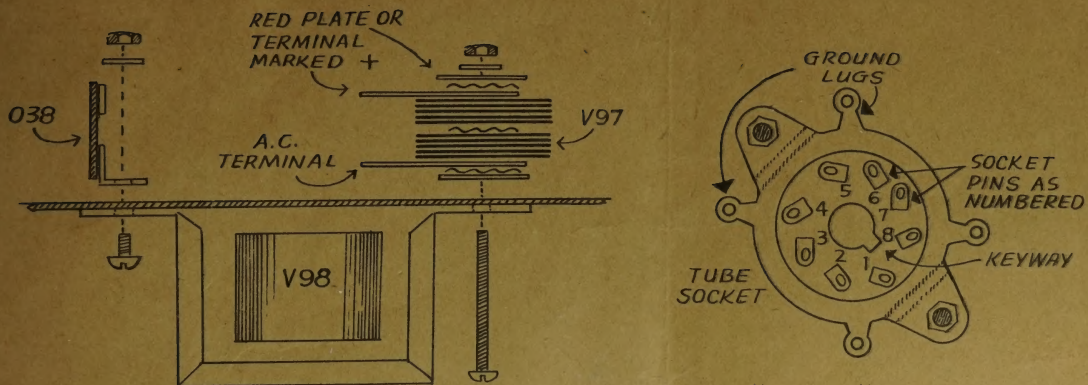
(S) means solder

(NS) means do not solder yet

### CHASSIS

1. On the chassis (V52C) mount the tube sockets (AR32) with 6-32 screws and lockwashers under the nuts. Make sure the keyways are toward the nearest edge of the chassis, as shown in the pictorial. Install the three  $\frac{1}{8}$  grommets (O35) in the holes in the chassis. Mount the AC and DC calibrate controls (V24) and the AC balance control (V108) with a control nut. Use a control lockwasher between control and chassis. Temporarily mount the Zero adjust (V63) and Ohms adjust (V25) controls with a control nut. Use a control lockwasher between control and chassis.





2. Mount the power transformer (V98) on top of the chassis, after passing the leads through the grommets. Use a short 6-32 screw on the side nearest the tube sockets and a long 6-32 screw on the other side. On the bottom side of the chassis a single terminal strip (O38) is mounted under the nut and lockwasher on the short screw, and the selenium rectifier (V97) is mounted under the nut and lockwasher on the long screw.

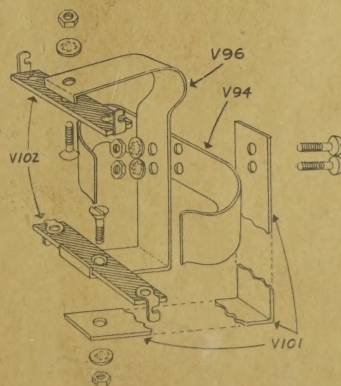
3. Cut the transformer leads to length and connect as follows: One yellow lead to ground lug (S) on 6H6 socket. Other yellow lead to pin #7 (NS) on 6H6 socket. One red lead to single terminal strip (NS). Other red lead to AC terminal (S) (nearest chassis) on rectifier. A wire to pin #7 (S) on 6H6 socket, and to pin #7 (NS) on 6SN7 socket.

4. Wire the 6H6 socket. A bare wire to pin #4 (S), and to ground lug (S). A bare wire to pin #2 (S), and through pin #1 (NS) to ground lug (S). A 10 meg resistor (C10) to pin #1 (S), and to pin #3 (NS). A 3.3 meg resistor (O10) through pin #5 (S) to nearest lug (S) on AC balance control, and to pin #3 (NS). A wire to pin #8 (S), and to center lug (S) on AC balance control.

5. Wire the 6SN7 socket. A 3.3 meg resistor (O10) to pin #1 (S), and to ground lug (NS). A 20K resistor (V22) to single terminal strip (NS), and to ground lug (S). A 15K resistor (V23) through pin #5 (NS) to pin #2 (S), and through pin #8 (S) to ground lug (S). A .003 condenser (V26) to pin #4 (NS), and to ground lug (S). A 2000 resistor (O15) to pin #3 (NS), and to lower lug (S) on Zero adjust control. A 2000 resistor (O15) to pin #6 (NS), and to upper lug (S) on Zero adjust control.

6. Complete the chassis wiring. A 47K resistor (A10) to single terminal strip (NS), and to center lug (S) on Zero adjust control. A wire to pin #5 (S) on 6SN7 socket, and to + terminal (NS) (farthest from chassis) on rectifier. A wire to inside lug (S) on AC calibrate control, and to pin #6 (NS) on 6SN7 socket. A wire to inside lug (S) on DC calibrate control, and to pin #6 (S) on 6SN7 socket. A wire to center lug (NS) on DC calibrate control, and to center lug (S) on Ohms adjust control. A 12 MFD condenser (V27) with the side marked positive (+) to + terminal (S) on rectifier, and other side of condenser to single terminal strip (S).

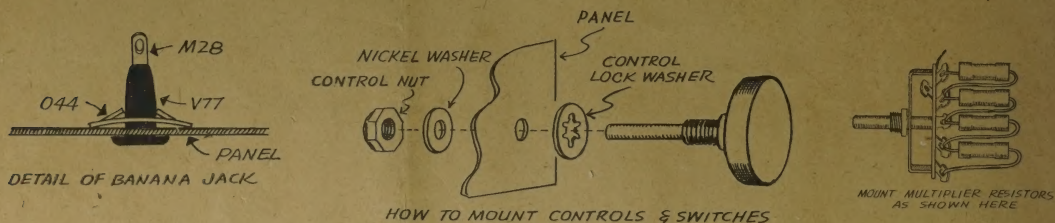
7. Assemble the battery bracket as shown and mount on top of the chassis with the flat head screw passing through V102 terminal strip assembly, V96 spring bracket, V101 stiffener bracket, the chassis, a single terminal strip (O38), a solder lug and a nut. A bare wire to solder lug (S), and to lug (S) on battery bracket nearest rear edge of chassis. A black lead from transformer to single terminal strip (NS). A wire between the top lugs (S) on the battery bracket.





## PANEL

8. On the panel (V51D) mount the pilot lamp assembly (O39, O40, O41, O42, O52) with the bracket toward the slide switch opening. Mount the slide switch (O94) with 6-32 screws and lockwashers under the nuts. Mount the banana jacks with speednuts (O44), the black jack (V77B) in the hole marked "Common" and the red jack (V77R) in the hole marked "AC Ohms." Push the banana jack inserts (M28) into the jacks from the front of the panel as far as they will go. Mount the phone jack (K17) with a control nut, using a control lockwasher between jack and panel and a nickel washer between panel and nut.



9. Mount the range switch (V75-3) on the panel with a control nut, using a control lockwasher between switch and panel and a nickel washer between panel and nut. Tighten nut partly. Temporarily install a pointer knob. Turn switch counterclockwise as far as it will go. Now turn the whole switch so the knob points at 3V-Rx1. Carefully remove knob and tighten nut.
10. Wire the range switch as shown in the pictorial by mounting the multiplier resistors (V103, V73, V74, V68, V66, V65, V69, V64, V76, V71, V72, and V70). Note that the 30K resistor (V66) connects to the grounded lug (NS) on the phone jack. The 8.3 resistor (V103) is soldered to the switch, without shortening the lead, after slipping on a piece of spaghetti. The other side is connected later. Do not solder one side of the 7 meg resistor (V72) until the wire to the selector switch is in place.
11. Install the selector switch (V106) with a control nut, using a control lockwasher between switch and panel and a nickel washer between panel and nut. Tighten nut partly. Temporarily install a pointer knob. Turn switch counterclockwise as far as it will go. Now turn the whole switch so the knob points at AC. Carefully remove knob and tighten nut.
12. Complete the panel wiring. A wire to lug #1 (S) on the front deck (nearest the panel) of the selector switch, and to a lug (S) on the range switch. A wire to lug #3 (S) on the front deck of the selector switch, and to a lug (S) on the range switch. A wire to lug #5 (S) on the front deck of the selector switch, and to the red banana jack (S). A wire to lug #10 (S) on the front deck of the selector switch, and to a lug (S) on the range switch. A wire to lug #11 (S) on front deck of the selector switch, and to the insulated contact (S) of the phone jack. A bare wire to the grounded contact (S) of the phone jack, and to the black banana jack (S). A bare wire to one lug (S) on pilot light socket, and to the bracket (S) as shown.

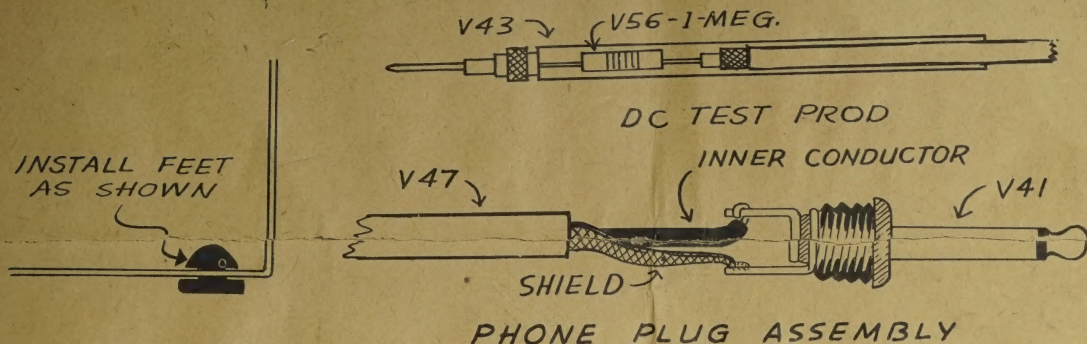
13. Mount the meter on the panel. Then remove the nuts holding the Zero adjust and Ohms adjust controls on the chassis, and slip the panel over the controls. Now fasten the controls with nickel washers between panel and control nuts.

## PANEL AND CHASSIS

14. Proceed to wire the panel to the chassis. A wire to lug #9 (S) on rear deck (farthest from panel) of the selector switch, and to nearest lug (S) on Ohms adjust control. A wire to lug #5 (S) on rear deck of the selector switch, and to center lug (S) on AC calibrate control. A bare wire to lug #7 (S) on rear deck of selector switch, and to pin #3 (S) on 6SN7 socket. A wire to lug #1 (S) on rear deck of selector switch, and to center lug (S) on DC calibrate control. A 3.3 meg resistor (O10) with spaghetti over the leads to lug #2 (S) on the front deck of the selector switch, and to pin #4 (S) on 6SN7 socket.



15. A wire to ungrounded lug (S) on pilot light assembly, and to pin #7 (S) on 6SN7 socket. Slip spaghetti over the lead of the 8.3 resistor from the range switch and connect to nearest lug (S) on battery terminal strip. A wire to lug #4 (S) on rear deck of selector switch, and through nearest grommet to meter lug (S) nearest the tube socket. A wire to lug #10 (S) on rear deck of selector switch, and through nearest grommet to meter lug (S) farthest from the tube socket. A .01/2000 condenser (V79) with spaghetti over the leads to lug #4 (S) on front deck of selector switch, and to pin #3 (S) on 6H6 socket. A wire to lug #9 (S) on front deck of selector switch, and to nearest lug (S) on AC balance control. A black wire from transformer to nearest lug (S) on slide switch. Install line cord (O78) through grommet, and after making a knot for strain relief, separate the leads as far as necessary. One lead to farthest lug (S) on slide switch. Other lead to single terminal strip (S).
16. Make up the test leads: The common lead is black test lead (V45) with a black banana plug (V39) on one end and an alligator clip (V44) on the other end. The AC ohms lead is red test lead (V46) with a red banana plug (V40) on one end and a red test prod (V42) on the other end. The DC lead is shielded test lead (V47) with a phone plug (V41) on one end and a small 1 meg resistor (V56) inside the black test prod (V53). Prepare the cabinet (V33) by installing the handle (O79) with 10-24 screws and by pushing the rubber feet (O34) into the holes in the bottom. Install the acorn knobs (V48) on the adjust controls, and the pointer knobs (O51) on the switches.



#### TEST AND CALIBRATION

Check the wiring over carefully. We suggest tracing over each wire on the pictorial with a colored pencil as it is checked on the instrument. Check each solder connection. Install the tubes.

Plug into a 117 Volt 50/60 Cycle AC ONLY outlet. This instrument will not operate and serious damage will result if plugged into a DC outlet.

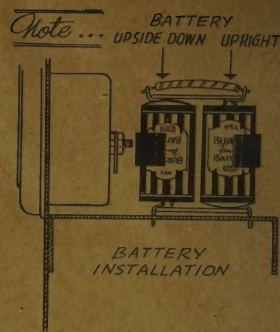
Turn Switch on and allow a minute for warm up. Set selector to DC+. Check operation of zero adjust control. Turning this control should move the meter pointer to about half scale and to zero. Set pointer to zero and check if it remains on zero when switched to DC-. If there is appreciable zero shift (more than one division on the scale) the tubes must be aged. First complete the initial test, however.

Turn the instrument off and make sure the mechanical zero of the meter is correct. If not, adjust as follows. Place instrument in normal operating position. (This usually is with the rubber feet on a level surface.) Turn the black plastic screw on the meter face with a screw driver, while gently tapping the meter face with one finger, until the pointer coincides with the zero line on the left side of the scale. Turn the instrument on again.

Insert the common and DC test leads. Set the selector switch to DC+ and the range switch to 3V. Connect the test leads to the calibrated flashlight cell and adjust the DC calibrate control so the meter pointer indicates the calibration voltage on the 3V scale.



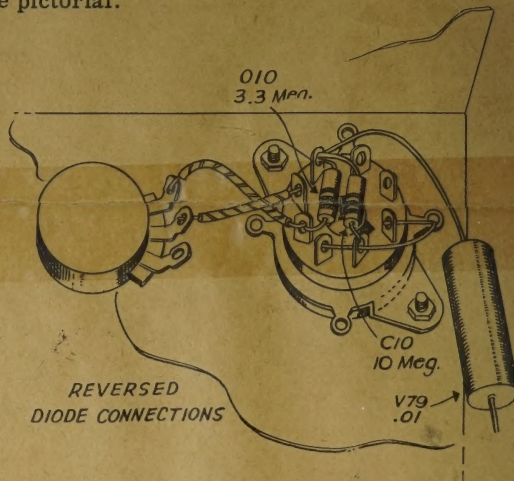
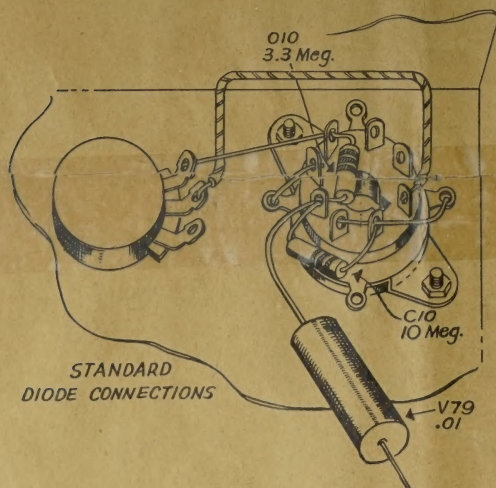
Install the batteries in the battery bracket as shown. Set selector switch to ohms. Pointer should swing to about full scale. Turn ohms adjust to give full scale reading (INFinite). Insert AC ohms test lead. Touch this lead to common lead and observe pointer dropping to zero indicating short circuit (no resistance).



Temporarily remove AC ohms test lead. Set range switch to 3V and selector to AC. Adjust AC balance control so no movement is noticed in the pointer when switching from AC through DC- to DC+. Now set range switch to 300V. Re-insert AC ohms lead. Connect AC ohms and common lead to the 117V AC line (NOTE: 117 Volt line is dangerous--proceed with due care) and adjust AC calibrate control so pointer indicates the line voltage.

It is recommended that the tubes be aged before final calibration. This is accomplished by keeping the instrument turned on for a period of at least 48 hours. Final calibration should be done in the same way as the initial calibration. Careful calibration will result in a more accurate instrument. If a standard AC meter is available, it is desirable to use such instrument, preferably at a voltage near full scale indication on the VTVM, as for instance 250 Volt or 90 Volt (on the 300V or 100V scale respectively).

If after a period of say 72 hours the AC balance control cannot keep the pointer from moving when switching from AC through DC- to DC+ with the range switch at 3V, the diodes should be interchanged. This should be done as shown in the pictorial.



After final calibration, install the instrument in the cabinet with sheet metal screws through the panel and in the rear into the chassis. This completes the instrument.

### CIRCUIT DESCRIPTION

This instrument uses a balanced vacuum tube circuit to increase the sensitivity and provide greater flexibility. The relationship between the test voltage applied to the tube and the indicating meter current is linear over a range appreciably greater than the operating range. When a much larger test voltage is accidentally applied, the relationship ceases to be linear and the indicating meter current is limited to a value of a few times full scale current. This makes the meter, when used in this circuit, virtually burn out proof. Repeated overloads should be avoided, however, as the pointer may be bent.

The zero adjust control balances the currents through the tubes and permits the meter to be set to zero, or partly up scale.



The calibration controls are in series with the meter and are adjusted to produce full scale reading with the proper test voltage applied to the instrument. The maximum test voltage applied to the tube is about 3 Volts. Higher test voltages are reduced by a voltage divider with a total resistance of 10 megohms. An additional resistor of 1 megohm is located in the DC test prod, which permits measurements to be made in circuits carrying R.F. with minimum disturbance of such circuits.

For AC voltages in the Audio Frequency range, a shunt fed diode is used to provide a DC voltage proportional to the peak of the applied AC voltage. This DC voltage is applied through the voltage divider to the tube, causing the meter to indicate. The AC calibrate control is used to get the proper meter deflection for the applied AC voltage. Vacuum tubes develop a contact potential voltage between tube elements. Such contact potential developed in the diode would cause a slight voltage to be present at all times. This voltage is cancelled out by bucking it with a portion of the contact potential of a second diode. The amount of bucking voltage is controlled by the AC balance control. This eliminates zero shift when switching from DC to AC.

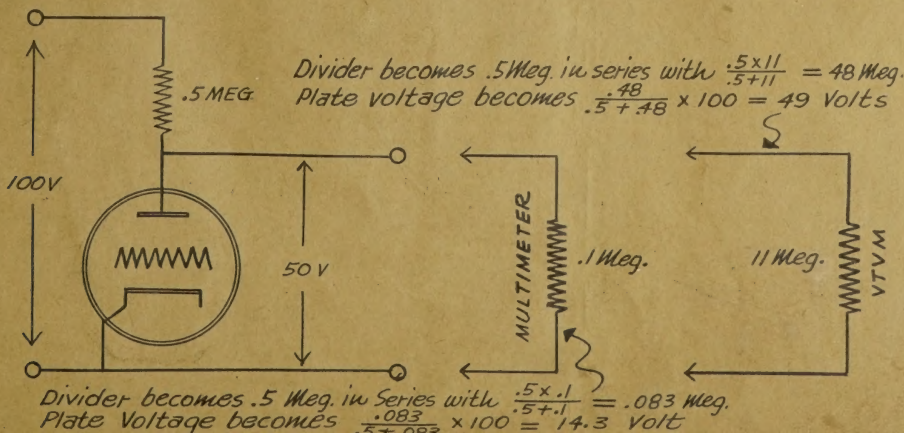
For resistance measurements, a 3 Volt battery is connected through a string of multipliers to the tube. The external resistance to be tested is connected between tube and common (chassis), forming, together with the multipliers, a voltage divider across the battery. The resultant portion of the battery voltage is thus applied to the tube causing the meter to deflect. The meter scale is calibrated in resistance.

### USING THE VTVM

**NOTE:** As the heaters are operated at a low temperature, the tube life is extremely long. The power consumption is very low. We therefore recommend that this instrument is turned on at the same time as the soldering iron for instance, and left on until the work is done. This will result in very stable operation, and the slight amount of heat generated inside the cabinet will keep the instrument free from moisture in humid climates.

The VTVM has many advantages over the non-electronic volt-ohmmeters. The greatest advantage is the high input resistance. This enables much more accurate readings to be obtained in high impedance circuits, such as resistance coupled amplifiers, oscillator grid circuits and AVC networks.

To illustrate this, let us assume a resistance coupled audio amplifier with a .5 megohm plate load resistor, operating with a 100 Volt plate supply. Let us also assume that the tube acts as a .5 megohm resistor. Measuring the plate voltage with a conventional 1,000 ohm per volt instrument on the 100 Volt scale, the meter can be considered a 100,000 ohm (.1 megohm) resistor in parallel with the tube. The voltage on the plate is then about 14 Volts and is shown as such by the meter. This is due to the shunt resistance of the low resistance meter. Using the VTVM on any scale setting, the full 11 megohm is placed in parallel with the tube. The voltage on the plate is then about 49 Volts or 2% lower than the normal operating voltage. Thus accurate reading can only be obtained with the high resistance provided by a VTVM.





Similar benefits are obtained in AVC, oscillator and other high resistance circuits.

An understanding of the characteristics of your instrument will result in greater satisfaction through proper use.

#### DC VOLTAGE

To measure DC voltage with the VTVM, connect the common (black) lead to the common or "cold" side of the voltage to be measured. Set the selector switch to DC+ or DC- as required, and set the range switch to a range greater than the voltage to be measured, if known. If unknown, set to 1,000 Volts. With black test prod, touch other or "hot" side of the voltage to be measured. If pointer moves less than one-third of full scale, switch to the next lower range.

#### AC VOLTAGE

To measure AC voltages with the VTVM, connect the common (black) lead to the common or "cold" side of the voltage to be measured. Set the selector switch to AC, and set the range switch to a range greater than the voltage to be measured, if known. If unknown, set to 1,000 Volts. With red test prod, touch other or "hot" side of the voltage to be measured. If pointer moves less than one-third of full scale, switch to the next lower range.

The Heathkit is an extremely sensitive electronic AC voltmeter and as the human body picks up AC when near any AC wires, the meter will indicate this pickup. Never touch the AC prod when on the lower ranges. Zero should be set with the AC prod shorted to the common clip.

#### RESISTANCE

To measure resistance with the VTVM, connect the common (black) lead to one side of the resistor to be measured. Set the selector to ohms, and set the range switch to such a range that the reading will fall as near to mid-scale as possible. ~~Set the ohms adjust control so the meter indicates exactly full scale (INF. on ohms scale).~~ Then touch the red test prod to the other side of the resistor to be measured. Read resistance on ohms scale and multiply by the proper factor as shown by the range switch setting.

Note: Although batteries are used to measure resistance, the indication is obtained through the electronic meter circuit, and therefore, the instrument must be connected to the AC power line and turned on.

CAUTION: Never leave the instrument on ohms, as it greatly shortens the life of the ohmmeter battery.

#### USING THE VTVM DECIBEL SCALE

Because the human ear does not respond to volume of sound in proportion to signal strength, a unit of measure called the "bel" was adopted. The "bel" is more nearly equivalent to human ratios. Normally the reading is given in 1/10 of a "bel" or "decibel."

Various signal levels are adopted by various manufacturers as standard or "0" decibels.

The Heathkit VTVM DB scale uses a standard of 6 milliwatts into a 500 ohm line as "0" decibels. This corresponds to 1.73 VAC on the 0-10 scale. From this figure, the various AC ranges of the VTVM may be converted to db by the following chart.

##### AC VOLTS SCALE

0-3V.  
0-30V.  
0-100V.  
0-300V.  
0-1000V.

##### DECIBEL SCALE

Subtract 10 db from reading  
Add 10 db to the reading  
Add 20 db to the reading  
Add 30 db to the reading  
Add 40 db to the reading



As the decibel is a power ratio or voltage ratio, it may be used as such without specifying the reference level. Thus for instance, a fidelity curve may be run on an amplifier by feeding in a signal of variable frequency but constant amplitude. At a reference frequency of say 400 cycles, adjust input to give a convenient indication (0 db for instance) on the VTVM connected to the output. As the input frequency is varied, the output level variation may be noted directly in db above and below the specified reference level.

NOTE: When measuring complex AC wave shapes, such as ripple, hum, distorted and square waves, the indication is 70% of the negative peak.

### READING THE METER SCALE

The voltage markings on the range switch refer to the FULL SCALE reading. The scale is marked 0-10 and 0-30 for voltage. On the 3 Volt range, read the 0-30 scale and drop the zero. On the 10 Volt range, read the 0-10 scale direct. On the 30 Volt range, read the 0-30 scale direct. On the 100 Volt range, read the 0-10 scale and add one zero. On the 300 Volt range, read the 0-30 scale and add one zero. On the 1,000 Volt range, read the 0-10 scale and add two zeros.

The resistance marking or ohms scale refers to the lowest resistance range (Rx1). For the other ranges, add the proper number of zeros (add two zeros for Rx100, add four zeros for Rx10K, add six zeros for Rx1 Meg). On the Rx1 Meg range, the scale can also be considered to read directly in megohms.



### ACCURACY

The accuracy of the meter movement is within 2% of full scale, which means that, for instance on the 1000 Volt range the accuracy of the movement will be within 20 Volts at any point of the scale. On DC, the accuracy of the multipliers (1%) may be additive, resulting in an accuracy of within 3% of full scale.

On AC, the accuracy of the rectifier circuit contributes variations which result in accuracy of within 5% of full scale.

The accuracy on the ohms ranges depends on the meter accuracy, the ohms multiplier accuracy (including the internal resistance of the batteries), and the stability of the battery voltage. On the Rx1 scale, the internal resistance of the batteries and the battery voltage both vary as a result of the current drawn by the resistance under test. For greatest accuracy, tests on low resistance values should be made as quickly as possible. On the higher ohms ranges, the accuracy depends practically on the multipliers, which are 1%, and the meter movement accuracy. Because of the non-linear ohms scale, the resulting accuracy is not readily expressed in a percentage figure, but the greatest accuracy is obtained at mid-scale readings.

Note: When comparing this instrument with another instrument, consider that the accuracy of the other instrument may deviate in the opposite direction. Therefore, when comparing two instruments of 5% accuracy, the difference might be a total of 10%. Critical comparisons should only be made against certified laboratory standards.



## IN CASE OF DIFFICULTY

1. Recheck the wiring. Most cases of trouble result from wrong or reversed connections. Often having a friend check the wiring will reveal a mistake consistently overlooked.
2. Check the tubes.

The possibility exists that a perfectly balanced tube will not permit Zero center adjustment on either DC+ or DC-. Then add 1000 ohms or more in series with one of the 2000 ohm resistors between 6SN7 tube socket and Zero adjust control.

3. If the pointer swings full scale to the right and stays there with switch set to DC+, check for an open circuit or high resistance connection someplace between the grid pin #4 of the 6SN7 and ground. This might be due to a wrong connection to the selector switches, poor connection or possibly an open resistor.

If the instrument does not operate on any function, a check of the power supply, 6SN7 and its associated meter circuit is suggested.

If the instrument only fails to function on AC measurements, then a check of the 6H6 and its associated circuits is indicated.

If the instrument only fails to function on ohms, the difficulty will probably lie in the batteries or the ohms multipliers.

Proper operation on DC should first be secured before an attempt is made to use the instrument on AC or ohms.

4. Check the operating voltages. The following voltages are measured to chassis: Pin #2 or #5 on 6SN7 tube or + lug on rectifier 40-70 Volts positive. Single terminal strip between tube sockets 60-100 Volts negative. Pin #7 on 6H6 or 6SN7 or "hot" lug on pilot light socket 5-6 Volts AC.
5. Check continuity through DC test cable. Make certain that the shielding is not shorted to center conductor.
6. Write to the Heath Company describing your difficulties and giving all possible details, such as voltages obtained, meter indications if any, model number etc. We will attempt to analyze your trouble and advise you accordingly.
7. If desired, your instrument may be returned to the factory. The Heath Company will inspect it and put it into operating condition for a service charge of \$3.00 plus the cost of any new parts or extra labor required due to damaged parts or improper construction.

NOTE: Before returning your instrument, make sure all parts are securely mounted, and that all eight screws (including the ones in the rear) holding the instrument in the cabinet are tight. Attach a tag with name, address and trouble experienced to the instrument. Include the test leads. Pack instrument in a rugged container, preferably wood, using at least three inches of shredded newspaper or excelsior on all sides. Do not use folded newspapers. Do not ship in original carton only. Ship by prepaid express if possible. Return shipment will be made by express collect.

NOTE that a carrier cannot be held liable for damage in transit if packing, in HIS opinion, is insufficient.



## BIBLIOGRAPHY

Many excellent articles on the construction and use of vacuum tube voltmeters have appeared in radio magazines. A few are:

RADIOCRAFT, June, 1945, Electronic Ohmmichecker  
RADIO NEWS, January, 1947, Home Constructed VTVM  
RADIO NEWS, July, 1946, Vacuum Tube Voltmeter  
RADIO NEWS, November, 1945, Electronic Volt-ohmmeter  
RADIO NEWS, February, 1946, Universal Test Instrument  
RADIOCRAFT, May, 1945, Practical VTVM  
VACUUM TUBE VOLTMETERS, A Book by John F. Rider

## RF TEST PROBE KIT

A test probe in kit form for use in measuring RF voltages of up to about 20 Volts is available for \$6.50. The kit contains all parts necessary for the construction of the probe, including 1N34 crystal detector, condensers, resistor, cable and connectors. This probe and cable is simply plugged into the instrument in place of the regular DC test probe assembly and the voltage is read on the lower regular DC ranges.

Order No. 309 RF Test Probe Kit-- \$5.50

## TELEVISION TEST PROBE KIT

A 30,000 volt test probe in kit form for use in testing the high DC voltages in Television receivers is available for \$5.50. The kit contains all parts necessary for the construction of the probe, such as the precision multiplier of 2% accuracy, the molded red and black body and handle, the connectors and the cable. This probe and cable is simply plugged into the instrument in place of the regular DC test probe and with the range switch set at 300 volt, 0 - 30,000 volts is read on the 0 - 30 scale. With range switch set at 100 volt or 30 volt, the instrument reads 0 - 10,000 volts on the 0 - 10 scale and 0 - 3,000 volts on the 0 - 30 scale.

Order No. 336 TV High Voltage Probe Kit--\$5.50

Prices subject to change without notice. The Heath Company reserves the right to change the design of its instruments without incurring liability for equipment previously supplied.

## WARRANTY

The Heath Company limits its warranty on any part supplied with any Heathkit (except tubes, meters, and rectifiers, where the original manufacturer's guarantee only applies) to the replacement within three (3) months of said part which, when returned with prior permission, postpaid, was in the judgment of the Heath Company, defective at the time of sale.

The assembler is urged to follow the instructions exactly as provided. The Heath Company assumes no responsibility for the operation of the completed instrument, nor liability for any damages or injuries sustained in the assembly or operation of the device.

HEATH COMPANY  
Benton Harbor, Michigan

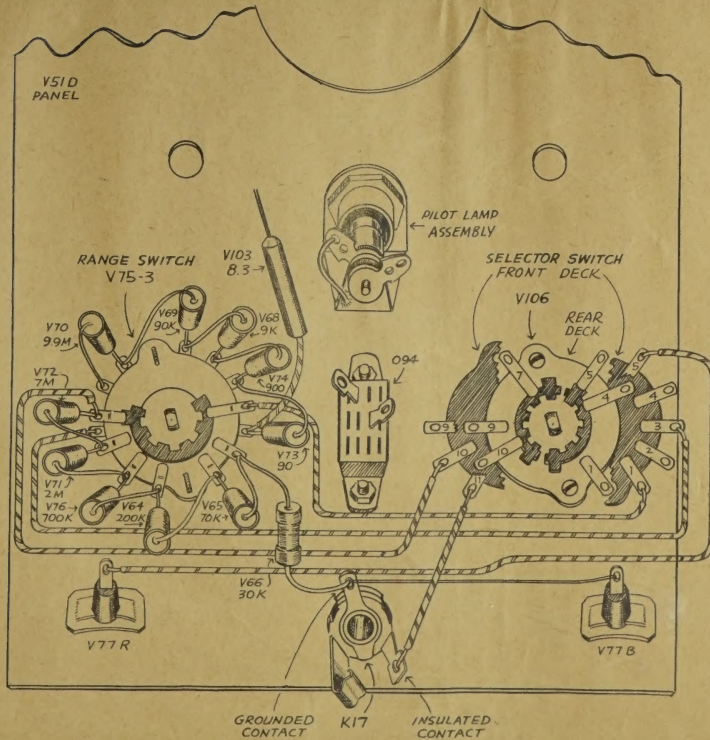
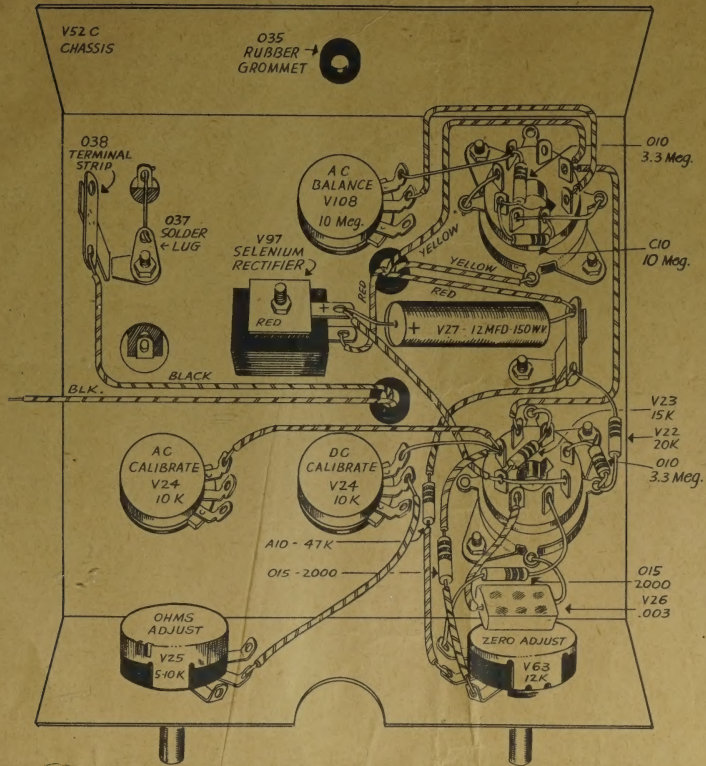


# V-4A VACUUM TUBE VOLTMETER PARTS LIST

Part No.	Parts Per Kit	Description	Part No.	Parts Per Kit	Description
Resistors			Tubes--Lamp		
V103	1	8.3 Ohm Precision	V31	1	6H6 or 6H6 GT Tube
V73	1	90 Ohm Precision	G44	1	6SN7 GT Tube
V74	1	900 Ohm Precision	O39	1	#47 Pilot Lamp
V68	1	9k Ohm Precision	Hardware		
V66	1	30k Ohm Precision	O31	9	6-32 x $\frac{3}{8}$ Screws
V65	1	70k Ohm Precision	K43	2	6-32 x $\frac{1}{2}$ Flat Head Screws
V69	1	90k Ohm Precision	IB48	1	6-32 x 1 Screw
V64	1	200k Ohm Precision	O102	8	#6 x $\frac{3}{8}$ Sheet Metal Screws
V76	1	700k Ohm Precision	O30	2	10-24 x $\frac{3}{8}$ Handle Screws
V71	1	2 Megohm Precision	S22	12	6-32 Nuts
V72	1	7 Megohm Precision	O33	8	Control Nuts
V70	1	9.9 Megohm Precision	TS72	11	#6 Lockwashers
C15	2	2,000 Ohm $\frac{5\%}{10}$	O101	8	Control Lockwashers
V23	1	15,000 Ohm	O28	5	Control Nickel Washers
V22	1	20,000 Ohm	O44	2	Speednuts for Jacks
A10	1	47,000 Ohm	O37	1	Solder Lug
V56	1	1 Megohm	O35	3	$\frac{3}{8}$ Grommets
O10	3	3.3 Megohm	O34	4	Rubber Feet
C10	1	10 Megohm	V94	1	Battery Spring Clip
Condensers			V96	1	Battery Spring Bracket
V26	1	.003 MFD	V101	1	Stiffener Bracket
V79	1	.01 MFD-2,000 Volt	Wire--Plugs--Prods--Clip		
V27	1	12 MFD-150 Volt	O77	1	Roll Hookup Wire
Controls			O81	1	Length Spaghetti
V24	2	10k Ohms (AC and DC calibrate)	V46	1	Length Red Test Lead
V25	1	*5k-10k Ohms (Ohms Adjust)	V45	1	Length Black Test Lead
V63	1	12k Ohms (Zero Adjust)	V47	1	Length Shielded Test Lead
V108	1	10 Megohm (AC balance)	O78	1	Line Cord
Switches			V40	1	Red Banana Plug
V106	1	Selector	V39	1	Black Banana Plug
V75-3	1	Range	V41	1	Phone Plug
O94	1	SPST Slide	V42	1	Red Test Prod
Sockets--Terminal Strips--Jacks			V43	1	Black Test Prod
AR32	2	Octal Sockets	V44	1	Alligator Clip
O52	1	Pilot Light Socket	Miscellaneous		
O40	1	Pilot Light Nut	V48	2	Acorn Knobs
O41	1	Pilot Light Bushing	O51	2	Pointer Knobs
O42	1	Pilot Light Jewel	V49C	1	200 Microamp. Meter
O38	2	Single Terminal Strips	V34	2	Flashlight Cells (one calibrated)
V102	2	Battery Term. Strip Assy.	V97	1	Selenium Rectifier
V77R	1	Banana Jack (red)	V98	1	Power Transformer
V77B	1	Banana Jack (black)	V51D	1	Panel
M28	2	Banana Jack Inserts	V52C	1	Chassis
K17	1	Phone Jack	V53	1	Cabinet
			O79	1	Handle

NOTE: \*V25 Control may be supplied in any value between 5,000 and 10,000 ohms.











# RMA Color Code on Transformers

## I.F. TRANSFORMERS

Blue — Plate Lead  
Red — B + Lead  
Green — Grid  
Black — Ground or AVC

If center tapped other grid is green and black striped

## AUDIO TRANSFORMERS

Blue — Plate Lead  
Red — B + Lead  
Brown — Other Plate on Push Pull  
Green — Grid Lead  
Black — Ground Lead  
Yellow — Other Grid on Push Pull

## POWER TRANSFORMERS PRIMARY — BLACK

High Voltage Plate — Red  
Center Tap Red and Yellow Striped

Rectifier Filament — Yellow  
Center Tap Yellow and Blue

Filament No. 1 — Green  
Center Tap Green and Yellow

Filament No. 2 — Brown  
Center Tap — Brown and Yellow

Filament No. 3 — Slate  
Center Tap — Slate and Yellow

## Soldering

The most important thing in good soldering is to heat the joint and allow the solder to flow into it. The solder should melt from contact with the joint rather than with the iron. Never use pastes or acids in radio work.

Use only rosin core solder. Never depend on the solder to hold a joint. Always make a firm connection with the wire before applying solder. To tin a soldering iron (soldering cannot be done with the bare copper) file the surface lightly while the iron is hot and then quickly apply a generous amount of rosin core solder while the filed surface is still bright. Wipe off excess solder with a cloth.

Tin all four sides of the tip in this manner.

The terminals must be clean, and preferably tinned. On some terminals that are hard to solder to (nickel plated f.i.) it is desirable to pre-tin the surface before installation or connection. Clean (scrape or sandpaper) the surface, heat with iron and apply rosin core solder liberally. Wipe off or shake off excess solder.










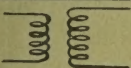

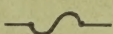
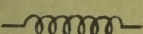
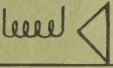
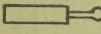
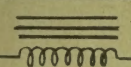

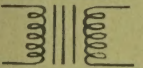

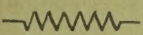


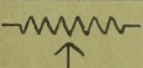
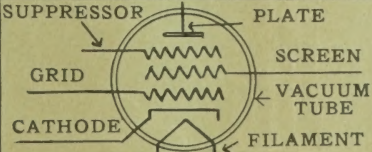

## Recommended Tools

A good electric soldering iron (100 watt with small tip)  
Long or needle nose pliers 6".  
Diagonal or side cutting pliers (5" or 6").  
An assortment of screw drivers flat and Phillips type.

File. Round and flat types.

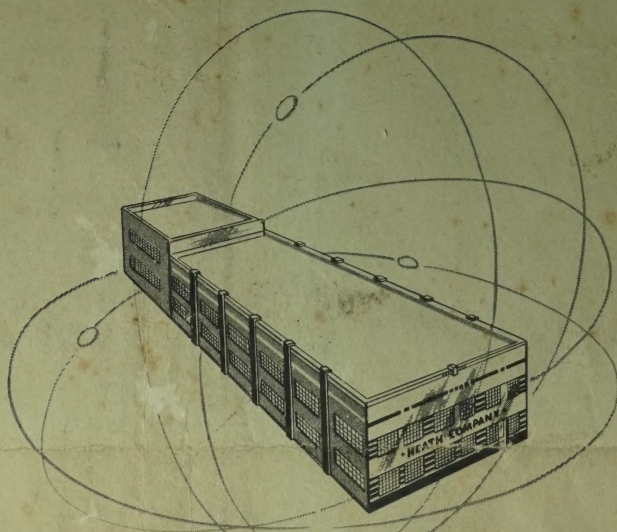
Purchase quality tools and you will enjoy and use them many years.  
American Beauty soldering irons, Plomb, and Williams pliers are recommended.

## Symbols Used in Radio Circuits

	ANTENNA OR AERIAL		VARIABLE CONDENSER		QUARTZ CRYSTAL
	CHASSIS OR GROUND		ELECTROLYTIC CONDENSER SHOWING POLARITY		CONNECTION OF TWO WIRES
	AIR CORE COIL		SWITCH		NO CONNECTION
	AIR CORE TRANSFORMER OR COIL		ROTARY SWITCH		FUSE
	R.F. CHOKE		SPEAKER		PHONE PLUG
	FILTER OR IRON CORE CHOKE . . .		METER	K =	1000
	IRON CORE TRANSFORMER		PILOT LIGHT	M =	1,000,000
	FIXED RESISTOR		PHONE JACK		OHM.
	VARIABLE RESISTOR OR POTENTIOMETER				MF = MICROFARAD
	FIXED CONDENSER				MMF = MICRO MICROFARAD

THE HEATH COMPANY . BENTON HARBOR, MICH.





THE HEATH COMPANY  
BENTON HARBOR, MICH.